Continental-Margin Processes Recorded in Shelf and Canyon Sediments

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LONG-TERM GOALS

The ultimate goal of this project is to understand how the relationship between sediment deposition and accumulation leads to the formation and preservation of sedimentary strata in the geological record.

OBJECTIVES

The objectives of this research are to:

1. characterize the 2000 Po River flood deposit and document its evolution,

2. examine the relationship of event and seasonal sediment deposition to longer-term sediment accumulation patterns along the western Adriatic coast,

3. investigate the transition from a point- to line-source dispersal system,

4. study sedimentation on the Apennine shelf clinoform,

5. assess historical changes in sedimentation, particularly along the Apennine coast.

APPROACH

Rapid-response box cores were collected following the 2000 Po River flood event, and sites were reoccupied during several cruises from 2001-2003 to document changes in the flood deposit. Samples were analyzed for the presence of the short-lived radioisotopes ^{7}Be and ^{234}Th as well as for grain size and sedimentary structures.

Box and kasten cores were collected along the western Adriatic coast from the Po River to the Gargano Peninsula to assess longer-term sedimentation using ^{210}Pb and ^{137}Cs. Box cores collected near the Pescara and Biferno Rivers during winter 2002-2003 were analyzed for ^{7}Be and ^{234}Th to assess short-term sediment deposition.

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WORK COMPLETED

During this past year, data analysis continued and results were synthesized. Research papers were submitted for publication on Po River sedimentation. Analyses of Apennine coast samples were continued.

In addition, initial studies (radiochemical analyses) were undertaken in submarine canyons from the Gulf of Lions. Charles A. Nittrouer was co-coordinator for the EuroSTRATAFORM project and was the chief editor for the STRATAFORM Master Volume.

RESULTS

a) Po River shelf

Using the maximum penetration depth of ^{7}Be to indicate sediment deposited following the 2000 Po River flood event, a seabed deposit was found on the Po shelf with thicknesses up to 15 cm. Individual depocenters were located immediately adjacent to the distributaries in relatively shallow (<30 m) water. These thicknesses are minimum estimates because the depth of ^{234}Th exceeds that of ^{7}Be in many cores, indicating that the first sediment delivered during the flood event likely originated from the river channel.

By integrating the ^{7}Be penetration depths over the study area, the mass of the 2000 flood deposit has been determined to be 1.53×10^{7} tons. This total may be an overestimate due to problems associated with the 1-cm sampling increments used (i.e., a mm-scale deposit would be included in the budget as a 1-cm thick deposit) and possible downward mixing of the ^{7}Be signal by biological processes. If sites that could have been impacted by these factors are excluded from the budget, the mass reduces to 1.46×10^{7} and 0.87×10^{7} tons, respectively. Unfortunately, the sediment discharge of the Po River was not measured during the flood event, but has been simulated using the HydroTrend model (Syvitski et al., submitted) to be 2.8×10^{7} tons. The mass of sediment in the flood deposit is 31-55% of this total, and the remainder is likely transported southward under the prevailing circulation of the Adriatic. The maximum penetration depth of ^{7}Be overestimates the amount of sediment delivered seasonally due to biological mixing. However, this effect can be removed by separating the ^{7}Be profile into an upper and lower portion representing new and downward-mixed sediment, respectively. Sediment deposition rates determined from this method are maximum (6 cm/y) near the Pila distributary, decreasing to 2 cm/y in the southern portion of the Po dispersal system.

Longer-term sediment accumulation rates have been determined for this area using ^{210}Pb (verified by ^{137}Cs). Near the Pila and Goro distributaries, accumulation is rapid (~2 cm/y) and non-steady state, reflecting the impact of event sedimentation related to floods. Between the two distributaries and in the southern portion of the dispersal system, accumulation is slower (reaching a minimum of 0.23 cm/y at ~50 km from the Pila mouth) and steady state. This likely represents sedimentation during non-flood periods. The pattern of sediment accumulation is similar to that of flood deposition, indicating that the Po shelf is event dominated. About half of the sediment delivered by the Po River over a 100-y time scale can be found on the shelf, and the rest is likely transported southward.

b) Apennine coast

Across-shelf accumulation rates reach a maximum on the foreset of the Apennine shelf clinoform (~1 cm/y), which is a relationship observed on other clinoforms. The clinoform is characterized by the presence of seafloor crenulations in some areas, and accumulation rates are 3-4 times higher on the steep than on the flat portions. Along-shelf accumulation rates show some variability with proximity to major rivers, but a general increase is observed southward along the margin and rates are greatest near the Gargano Peninsula (~1.5 cm/y). This pattern contrasts with those observed near other line-source systems such as the Gulf of Alaska, where distinct depocenters are observed adjacent to individual rivers, and the Gulf of Papua, where sediment supplied by the numerous rivers coalesces in the central area.

Accumulation rates in this area have been reduced over the past ~50 y, as evidenced by changes in ^{210}Pb profiles. This is likely due to anthropogenic activities such as dam construction following WWII. However, observations near the Pescara and Biferno Rivers using ^{7}Be and ^{234}Th have indicated that some new sediment is reaching the shelf, especially following periods of elevated river discharge.

IMPACT/APPLICATIONS

The research completed in this project leads to an improved understanding of the processes that control the geometry of sedimentary deposits over multiple time scales, especially deposits emanating from line-source systems. Also, knowledge of the impacts of anthropogenic activities on these deposits is enhanced.

TRANSITIONS

Other EuroSTRATAFORM investigators are using results from this effort. Those studying the seabed incorporate radiochemical and textural data to document seabed characteristics more fully. Researchers analyzing boundary layer processes also utilize this data to describe instrumentation sites. Accumulation rates, sediment budgets, and grain-size data are key components to the input parameters of models.

RELATED PROJECTS

Related projects include studies of: the seabed by R. Wheatcroft, P. Wiberg, T. Milligan, and P. Hill; boundary layer process by A. Ogston, C. Sherwood, P. Traykovski, and P. Puig; plume dynamics by G. Kineke, R. Geyer; modeling by C. Harris; and organic carbon by S. Miserocchi and L. Langone.

PUBLICATIONS

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